Alcohol Abuse Disorders Among U.S. Service Members With Mild Traumatic Brain Injury

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ABSTRACT Traumatic brain injury (TBI) has emerged as a preeminent injury in Iraq and Afghanistan. The relationship between TBI and post-injury alcohol use in military personnel has not been clearly defined. The aim of this study was to examine the prevalence of alcohol abuse disorders among combat-injured service members with mild TBI (MTBI). Male U.S. service members with combat injuries were identified from the Expeditionary Medical Encounter Database (n = 3,123). Diagnoses of alcohol abuse disorders were collected from the standard inpatient and ambulatory data records. Overall, a slightly higher proportion of service members with MTBI were diagnosed with an alcohol abuse disorder compared to those with other injury (6.1% vs. 4.9%). In a multivariate analysis, however, it was found that MTBI was not associated with higher levels of alcohol abuse (odds ratio, 1.24; 95% confidence interval, 0.90, 1.70). To better define the consequences of MTBI, future research should include other alcohol dependency measures along with comorbid mental health disorders.

INTRODUCTION

Traumatic brain injury (TBI) has emerged as a preeminent injury in Iraq and Afghanistan, where a significantly higher percentage of head, neck, and face wounds have been observed than in previous wars.[1–3] A recent study of the current conflicts in Iraq and Afghanistan has demonstrated that nearly 70% of wounded service members were injured in a blast.[4] The emergence of novel blast mechanisms, such as improvised explosive devices, has contributed to the increase in injuries,[1] as have advancements in personal protective equipment (e.g., Kevlar helmets) and battlefield medical care, which have rendered the previously fatal wounds survivable.[5,6] At Walter Reed Medical Center, these blast injuries are significant, with over half the patients being diagnosed with a TBI.[7] This increased survivability has led to a heightened focus on the physical, psychological, and behavioral consequences of battlefield TBI, particularly mild TBI (MTBI).

The relationship between TBI and post-injury alcohol use in civilians and military personnel has not been clearly defined. In civilians with TBI, alcohol use before injury (or intoxication at the time of injury) is common,[8–11] but appears to decline after injury. This change in behavior among civilians may be due to the identification of alcohol use as a problem.[12–15] In contrast to civilians, combat-related TBIs among military personnel do not occur in conjunction with alcohol intoxication at the time of injury; alcohol is heavily regulated and not readily available in military combat zones. However, alcohol abuse is prevalent following a combat deployment and is a significant contributor to morbidity in the U.S. military.[16–18]

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A recent survey providing baseline level of alcohol use in military personnel found that 1 in 5 service members were heavy drinkers.[19] Alcohol abuse is a behavior-related problem with psychiatric and post-operative morbidities,[20–22] and the prevalence of alcohol abuse following MTBI is unclear.[5,6,8–14,23,24] Limitations of previous research on the MTBI and alcohol abuse relationship include the lack of an injured control group and the use of self-report measures.[12,13,19,23,25,26] Self-report estimates of alcohol abuse range from 10% to 32% in post-injury samples.[13,14,23,24] The aim of the present study was to compare the prevalence of clinically diagnosed, post-injury alcohol abuse disorders among service members with MTBI and other injuries using health care utilization data.

METHODS

Study Sample

The study sample was identified from the U.S. Expeditionary Medical Encounter Database (EMED), formerly known as the Navy–Marine Corps Combat Trauma Registry. The EMED, a deployment health database maintained by the Naval Health Research Center, San Diego, California, consists of documented clinical encounters of service members deployed in support of Operations Enduring and Iraqi Freedom.[1] In this study, the sample consisted of U.S. Navy, Marine Corps, and Army personnel who were treated for combat injuries at forward-deployed medical treatment facilities (i.e., those in the combat zone and nearest to the point of injury). We queried for U.S. military personnel injured from March 2004 to June 2007 in the EMED, which yielded 7,247 wounded service members. We excluded patients with non–combat-related injuries (N = 2,895), multiple injury events (N = 267), non-blast injuries (N = 794), alcohol abuse disorders before injury (N = 118), and females (N = 50).

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14. ABSTRACT

Traumatic brain injury (TBI) has emerged as a preeminent injury in Iraq and Afghanistan. The relationship between TBI and post-injury alcohol use in military personnel has not been clearly defined. The aim of this study was to examine the prevalence of alcohol abuse disorders among combat-injured service members with mild TBI (MTBI). Male U.S. service members with combat injuries were identified from the expeditionary Medical Encounter Database (n=3,123). Diagnoses of alcohol abuse disorders were collected from the standard inpatient and ambulatory data records. Overall, a slightly higher proportion of service members with MTBI were diagnosed with an alcohol abuse disorder compared to those with other injury (6.1% vs.. 4.9%). In a multivariate analysis, however, it was found that MTBI was not associated with higher levels of alcohol abuse (odds ration, 1.24; 95% confidence interval, 0.90, 1.70). To better define the consequences of MTBI, future research should include other alcohol dependency measures along with comorbid mental health disorders.

15. SUBJECT TERMS

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Measures

Combat injuries (any injury that resulted from hostile action) were classified with a thorough review of EMED records by the clinical research staff. The mechanisms of injury were limited to blasts. Injury severity was calculated using the injury severity score (ISS) for each patient in the EMED.[27] Only those with an ISS of 1 to 8 were included in the present analysis and categorized as minor (ISS 1–3) or moderate (ISS 4–8). TBI, the exposure of interest, was defined according to the criteria established by the Centers for Disease Control and Prevention, as indicated by any one of the following International Classification of Diseases 9th Revision, Clinical Modification (ICD-9-CM) codes from EMED records: 800.0 to 801.9, 803.0 to 804.9, or 850.0 to 854.1.[28]

Inpatient and outpatient alcohol abuse diagnoses were obtained from medical records managed by the Office of the Secretary of Defense, Health Affairs, TRICARE Management Activity (i.e., Standard Inpatient Data Record and Standard Ambulatory Data Record). Diagnoses were coded by credentialed providers at military treatment facilities and federally reimbursed private clinics using ICD-9-CM codes.[29] Table I shows the ICD-9-CM codes used for identifying patients with alcohol abuse diagnoses. Alcohol-related diagnoses were collected for 2 years of follow-up from the date of injury. Mental health diagnoses before injury, ICD-9-CM codes 290 to 316, excluding 305.1, were also abstracted from standard inpatient data and standard ambulatory data records.

Deployment data were obtained from the Defense Manpower Data Center to determine the education and marital status of each service member during the deployment that resulted in injury. Age, military rank, and service were extracted from the EMED clinical record. Rank was categorized as junior enlisted (E1–E3), enlisted (E4–E5), or senior enlisted/warrant officer/officer (E6–E9, W1–W4, or O1–O6).

TABLE I. Frequency of Alcohol Abuse Diagnoses Among 3,123 Male Service Members with Blast-related Combat Injury

ICD-9-CM Diagnoses	Alcohol Use Description	MTBI (n = 1,413)	Control (n = 1,710)
291.0	Alcohol Intoxication and Withdrawal Delirium	1	
291.1	Alcohol-induced Persisting Amnestic Disorder		
291.2	Alcohol-induced Persisting Dementia		
291.3	Alcohol-induced Psychotic Disorder, With Hallucinations		
291.5	Alcohol-induced Psychotic Disorder, With Delusions		
291.81	Alcohol Withdrawal	2	1
291.89	Alcohol-induced Sleep Disorder		1
291.9	Alcohol-related Disorder not otherwise specified	2	2
303.00–303.02	Alcohol Dependence Syndrome	4	5
303.90–303.92	Other and Unspecified Alcohol Dependence	35	34
305.00–305.02	Alcohol Abuse	58	58
Total Alcohol-related Diagnoses		102	101
Total Patients (%) With Alcohol Diagnosis		86 (6.1)	84 (4.9)

Statistical Analysis

Chi-square (χ^2) tests were used to assess categorical variables. Tests were 2-tailed and $p < 0.05$ was used to determine statistical significance. Multivariate analysis was conducted using logistic regression. Covariates with a $p < 0.10$ were assessed for confounding using a 10% variation in the crude odds ratio (OR). The Hosmer–Lemeshow test was used to assess goodness of fit of the final logistic model. All statistical analyses were performed using SPSS software, version 16.0 (SPSS, Chicago, Illinois).

RESULTS

The study sample consisted of 3,123 U.S. service members from 2004 to 2007 with blast-induced mild-to-moderate injuries. Of these, 1,413 (45.2%) had MTBI and 1,710 (54.8%) had other combat injuries. Over 6% (n = 86) of service members with MTBI were diagnosed with a post-deployment alcohol abuse disorder compared with only 4.9% (n = 84) in the other injury group (Table I).

Median age was 22.6 years and ranged from 18 to 58 years. Table II shows that a higher proportion of service members with MTBI were Marines (χ^2 = 51.02, degree of freedom (df) = 2, $p < 0.001$) and were junior enlisted (χ^2 = 35.49, df = 2, $p < 0.001$) than those with other injuries. A significantly higher proportion of those with MTBI had an ISS of 4 to 8 compared with the other injured service members (χ^2 = 79.96, df = 1, $p < 0.001$). Conversely, patients without MTBI had a higher level of education in relation to those with MTBI (χ^2 = 6.97, df = 2, p = 0.02).

Mental health diagnosis before injury and marital status did not meet our criteria for confounding and therefore were not included in the multivariable analyses. In multivariate analyses, it was found that the odds of alcohol abuse among service members with combat-related MTBI were higher than those with other combat-related injuries, but the relationship was not statistically significant (Table III). There was an association, however, between alcohol abuse diagnosis and age at the time of injury. Service members aged 22 to 24 years and 25 years and older had significantly lower odds of alcohol abuse diagnosis compared with 18-year olds to 21-year olds (OR, 0.60; 95% confidence interval [CI], 0.42, 0.86 and OR, 0.34; 95% CI, 0.23, 0.52, respectively). The Hosmer–Lemeshow test indicated that the model was a good fit (p = 0.87).

DISCUSSION

TBI is an emerging health problem among service members returning from deployment and is associated with a wide array of adverse outcomes. Our findings indicate, however, that

TABLE II. Distribution of Sample Characteristics Among 3,123 Male Service Members with Blast-related Combat Injury

Variables	MTBI (n = 1,413)	Control (n = 1,710)	p Value
Age (years), no. (%)			0.02
18–21	372 (26.3)	426 (24.9)	
22–24	555 (39.3)	613 (35.8)	
≥25	486 (34.4)	671 (39.2)	
Branch of Service, no. (%)			<0.001
Army	168 (11.9)	369 (21.6)	
Marine Corps	1,163 (82.3)	1,253 (73.3)	
Navy	82 (5.8)	88 (5.1)	
Marital Status, no. (%)			0.81
Not Married	878 (62.1)	1,057 (61.8)	
Married	483 (34.2)	592 (34.6)	
Unknown	52 (3.7)	61 (3.6)	
Rank, no. (%)			<0.001
E1–E3	676 (47.8)	662 (38.7)	
E4–E5	519 (36.7)	728 (42.6)	
E6–Officers	145 (10.3)	258 (15.1)	
Unknown	73 (5.2)	62 (3.6)	
Level of Education, no. (%)			0.02
<High School	67 (4.9)	99 (5.8)	
High School Graduate	1,181 (83.6)	1,400 (81.9)	
≥Some College	76 (5.3)	128 (7.5)	
Unknown	89 (6.3)	83 (4.9)	
Mental Health Diagnosis Before Injury, no. (%)			0.12
Yes	75 (5.3)	68 (4.0)	
No	1,338 (94.7)	1,642 (96.0)	
Injury Severity, no. (%)			<0.001
Moderate	475 (33.6)	334 (19.5)	
Mild	938 (66.4)	1,376 (80.5)	

TABLE III. Multivariable Analyses of Alcohol Abuse Among 3,123 Male Service Members with Blast-related Combat Injury

Variables	Crude OR (95% CI)	Adjusted OR[a] (95% CI)
Injury Type		
MTBI	1.27 (0.93, 1.74)	1.24 (0.90, 1.70)
Other Minor Injury	1.00	1.00
Age (year)		
≥25	0.34* (0.22, 0.52)	0.34* (0.23, 0.52)
22–24	0.60* (0.42, 0.86)	0.60* (0.42, 0.86)
18–21	1.00	1.00
Rank		
E6–Officers	0.21* (0.10, 0.47)	
E4–E5	0.46* (0.33, 0.66)	
E1–E3	1.00	
Branch of Service		
Marine Corps	0.85 (0.57, 1.26)	
Navy	0.78 (0.35, 1.73)	
Army	1.00	
Level of Education		
<High School	4.97* (1.62, 15.27)	
High School Graduate	2.72 (0.99, 7.42)	
≥Some College	1.00	
Injury Severity		
Moderate	1.28 (0.91, 1.81)	
Mild	1.00	

*$p < 0.05$. [a]Rank, branch of service, level of education, and injury severity did not meet the criteria for confounding and were not included in the multivariable model.

combat-related MTBI is not associated with new-onset alcohol abuse disorders. To our knowledge, this is the first outcome study to compare the prevalence of new-onset alcohol abuse disorders among service members with combat-related MTBI and other combat injuries.

Overall, the rate of alcohol abuse disorders in the sample was approximately 5%. Two other comparable studies examining the rates of substance abuse disorders (alcohol and drug abuse disorders) found similar results, with a prevalence of 5% among a sample of veterans from Iraq and Afghanistan[30] and 4.1% among Operation Iraqi Freedom veterans with nonbattle injuries.[31] Self-report studies, however, have demonstrated a prevalence of post-injury alcohol abuse ranging from 10% to 32%.[13,14,23,24] A plausible justification for the low prevalence of diagnosed alcohol abuse disorders in the present study could be related to service members' inability or reluctance to discuss these issues with medical professionals. Service members may also seek professional assistance outside the military health care system, and therefore, would not be captured in health care–related military databases.

The primary finding of this study—no association between MTBI and subsequent diagnosis of alcohol abuse—was unexpected. It is possible that combat injury is a correlate of alcohol abuse, but MTBI does not mediate the relationship. Another explanation for the null finding may be the length of follow-up period. Some research suggests that an increase in alcohol consumption emerges approximately 2 years after injury.[13] Extending the follow-up period for alcohol abuse diagnosis beyond 2 years in this sample, however, may obscure any association with the injury event. The secondary finding of younger service members being more likely to be diagnosed with alcohol abuse disorder is confirmed by the literature illustrating influence of age on alcohol consumption.[32,33]

The primary strengths of this study were the large sample size, the use of an injured control group, and the nature of the military population that allowed for studying non–alcohol-related TBI. The limitations of this study include the possible underestimation of the incidences of mild injury and diagnosis of alcohol abuse. Service members with a mild injury who do not seek medical attention were not included in this study. This effect may be strongest in the MTBI group since service members often fail to be examined following a blast exposure when no physical signs of injury are present. In addition, it is possible that not all service members are forthcoming regarding habitual alcohol abuse during medical visits because of perceived, negative career consequences. As such, alcohol use following combat-related injury may be more prevalent than indicated by this study and using self-report data could improve the detection of alcohol abuse that otherwise clinical diagnoses would not capture.

Alcohol abuse negatively affects numerous military personnel and their families. Although the present study did not

identify a statistical relationship between MTBI and subsequent alcohol abuse disorders, our findings indicate prevalence of abuse may be slightly higher among those with mild brain injury. These findings reiterate that alcohol abuse is a dependency issue in the military community, including those who return from deployment with combat injuries. Future research should incorporate self-reported measures of alcohol dependency to identify at-risk military populations who do not seek medical attention, along with examining the impact comorbid mental health disorders have as a consequence from MTBI.

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REFERENCES

1. Wade AL, Dye JL, Mohrle CR, Galarneau MR: Head, face, and neck injuries during Operation Iraqi Freedom II: results from the US Navy-Marine Corps Combat Trauma Registry. J Trauma 2007; 63: 836–40.
2. Owens BD, Kragh JF Jr, Wenke JC, Macaitis J, Wade CE, Holcomb JB: Combat wounds in Operation Iraqi Freedom and Operation Enduring Freedom. J Trauma 2008; 64: 295–9.
3. Reister FA: Battle Casualties and Medical Statistics: US Army Experience in the Korean War, Chapter 3. Washington, DC, Department of the Army, Office of the Surgeon General, 1973.
4. Chandler D: Blast-related ear injury in current U.S. military operations. The ASHA Leader. 2006; 11: 8–9, 29.
5. Xydakis MS, Fravell MD, Nasser KE, Casler JD: Analysis of battlefield head and neck injuries in Iraq and Afghanistan. Otolaryngol Head Neck Surg 2005; 133: 497–504.
6. Gawande A: Casualties of war: military care for the wounded from Iraq and Afghanistan. New Engl J Med 2004; 351: 2471–5.
7. Okie S: Traumatic brain injury in the war zone. New Engl J Med 2005; 352: 2043–7.
8. Corrigan JD: Substance abuse as a mediating factor in outcome from traumatic brain injury. Arch Phys Med Rehabil 1995; 76: 302–9.
9. Gurney JG, Rivara FP, Mueller BA, Newell DW, Copass MK, Jurkovich GJ: The effects of alcohol intoxication on the initial treatment and hospital course of patients with acute brain injury. J Trauma 1992; 33: 709–13.
10. Kraus JF, Morgenstern H, Fife D, Conroy C, Nourjah P: Blood alcohol tests, prevalence of involvement and outcomes following brain injury. Am J Public Health 1989; 79: 294–9.
11. Sparadeo FR, Gill D: Effects of prior alcohol use on head injury recovery. J Head Trauma Rehabil 1989; 4: 75–82.
12. Bombardier CH, Temkin NR, Machamer J, Dikmen SS: The natural history of drinking and alcohol-related problems after traumatic brain injury. Arch Phys Med Rehabil 2003; 84: 185–91.
13. Kreutzer JS, Witol AD, Marwitz JH: Alcohol and drug use among young persons with traumatic brain injury. J Learn Disabil 1996; 29: 643–51.
14. Kolakowsky-Hayner SA, Gourley EV, Kreutzer JS, Marwitz JH, Meade MA, Cifu DX: Post-injury substance abuse among persons with brain injury and persons with spinal cord injury. Brain Inj 2002; 16: 583–92.
15. Ponsford J, Whelan-Goodinson R, Bahar-Fuchs A: Alcohol and drug use following traumatic brain injury: a prospective study. Brain Inj 2007; 21: 1385–92.
16. Jacobson IG, Ryan MAK, Hooper TI, et al: Alcohol use and alcohol-related problems before and after military combat deployment. JAMA 2008; 300: 663–75.
17. Self-reported illness and health status among Gulf War veterans: a population-based study. The Iowa Persian Gulf Study Group. JAMA 1997; 277: 238–45.
18. Richards MS, Goldberg J, Rodin MB, Anderson RJ: Alcohol consumption and problem drinking in white male veterans and nonveterans. Am J Public Health 1989; 79: 1011–5.
19. Bray RM, Sanchez RP, Ornstein ML, et al: 1998 Department of Defense survey of health related behaviors among military personnel. Research Triangle Park, NC, 1999.
20. Farrell M, Howes S, Bebbington P, et al: Alcohol and drug dependence and psychiatric comorbidity. Br J Psychiatry 2001; 179: 432–7.
21. Tonneson H, Rosenberg J, Nielsen HJ, et al: Effect of preoperative abstinence on poor postoperative outcome in alcohol misusers: randomized controlled trial. BMJ 1999; 318: 1311–6.
22. Tonnesen H, Pedersen AE, Jensen MR, Moller A, Madsen JC: Ankle fractures and alcoholism. The influence of alcoholism on morbidity after malleolar fractures. J Bone Joint Surg 1991; 73: 511–3.
23. Sander AM, Witol AD, Kreutzer JS: Alcohol use after traumatic brain injury: concordance of patients' and relatives' reports. Arch Phys Med Rehabil 1997; 78: 138–42.
24. Hall KM, Karzmark P, Stevens M, Englander J, O'Hare P, Wright J: Family stressors in traumatic brain injury: a two-year follow-up. Arch Phys Med Rehabil 1994; 75: 876–84.
25. Ames GM, Cunradi CB, Moore RS: Alcohol, tobacco, and drug use among young adults prior to entering the military. Prev Sci 2002; 3: 135–44.
26. Corrigan JD, Smith-Knapp K, Granger CV: Outcomes in the first 5 years after traumatic brain injury. Arch Phys Med Rehabil 1998; 79: 298–305.
27. Baker SP, O'Neill B, Haddon W, Long WB: The injury severity score: a method for describing patients with multiple injuries and evaluating emergency care. J Trauma 1974; 14: 187–96.
28. National Center for Injury Prevention and Control. Report to Congress on Mild Traumatic Brain Injury in the United States: Steps to Prevent a Serious Public Health Problem. Atlanta, GA, Centers for Disease Control and Prevention, 2003.
29. Larson GE, Highfill-McRoy RM, Booth-Kewley S: Psychiatric diagnoses in historic and contemporary military cohorts: combat deployment and the healthy warrior effect. Am J Epidemiol 2008; 167: 1269–76.
30. Seal KH, Bertenthal D, Miner CR, Sen S, Marmar C: Bringing the war back home: mental health disorders among 103,788 US veterans returning from Iraq and Afghanistan seen at Department of Veterans Affairs facilities. Arch Intern Med 2007; 167: 476–82.
31. MacGregor AJ, Shaffer RA, Dougherty AL, et al: Psychological correlates of battle and nonbattle injury among Operation Iraqi Freedom veterans. Mil Med 2009; 174: 224–31.
32. Kalaydijan A, Swendsen J, Chiu WT, et al: Sociodemographic predictors of transitions across stages of alcohol use, disorders, and remission in the National Comorbidity Survey replication. Compr Psychiatry 2009; 50: 299–306.
33. Horner MD, Ferguson PL, Selassie AW, Labbate LA, Kniele K, Corrigan JD: Patterns of alcohol use 1 year after traumatic brain injury: a population-based, epidemiological study. J Int Neuropsychol Soc 2005; 11: 322–30.